CONGRESSIONAL BILL ABOUT BRIDGES OVER NAVIGABLE STREAMS.

The committee of the Merchants' Exchange of St. Louis, to whom was referred the subject of bridges across the Ohio River, has returned a report to the Board of Directors. The committee conferred with C. Shaler Smith, C. E., and together a bill was adopted covering all essential points. The committee urged the immediate adoption of the bill as the sentiment of the Merchants' Exchange, and that as the subject is now prominently before Congress, and there is known to be at least eight or ten bridge bills asking charters for bridges across navigable streams of the West at the present time, they would suggest the importance of immediate action.

From the St. Louis *Globe-Democrat* we take the following synopsis of the bill:

The bill provides that in all low bridges with draw-spans across the Mississippi, Missouri and Illinois rivers there shall be one protecting pier of masonry, crib-work or piling, extending from the upper end of the pivot pier, or one of the rest piers of the draw or pivot span, up-stream for the distance of 1,000 feet from the center line of the bridge, or such other distance as may be determined by the Board of Engineers created here in this act; and which protection pier shall be properly arranged with ring-bolts and fender planking, so as to enable boats to tie up alongside of it and drop down through the draw openings at such times as it may be dangerous to attempt the passage of the draw when under headway.

A second pivot-span is required in all bridges located near a city or harbor, to facilitate the passage of craft tied to the banks, and it is provided "that the piers of all spans shall be built parallel with the current of the river at that stage of water which is most important for navigation, and that rip-rapping or other protection for imperfect foundations, which will materially lessen the required water way, will not be permitted in the channel ways of the high spans or of the draw openings.

"That in case the approaches to draw-span openings, channel-shafts, or raft passages in bridges authorized by this act are found to be dangerous or difficult of access by any important class of river traffic, the Secretary of War may, upon the recommendation of a Board of Engineers, order the construction of such sheer booms as will obviate the difficulty mentioned; which sheer booms shall be paid for by the parties owning, controlling or operating the said bridge.

"That all high bridges over the Missouri River above the mouth of the Osage River shall have two or more channel-spans located and having not less than 300 ft. clear width of channel way each; and that all low bridges in the same section shall have openings giving 160 ft. clear channel way in each opening.

"That all low bridges hereafter built over the Mississippi River, between the mouth of the Illinois River and a point eight miles above the Eads bridge over the Mississippi River at St. Louis, Mo., shall be located as prescribed in the act, except that they shall have at least one draw or pivot-span opening of not less than 400 ft. clear channel way, which shall be located over that channel of the river which is most convenient and accessible to boats with tows at all stages of water; and in case this location of the said draw or pivot-span does not bring an opening near the shore, then there shall be an additional draw or pivot-span provided elsewhere for the passage of single boats, which said draw or pivot-span shall have at least one opening of not less than 200 ft. clear channel way. Also, that all fixed spans between the shore lines at the medium stage of water shall be 300 ft. or more in length; and that the clear head-room under such spans shall not be less than 10 ft. at highest water."

The other provisions of the act prescribe high bridges, with two channel-spans of not less than 500 ft. clear channel on the Mississippi above the Eads bridge and to the mouth of the Ohio. Below the Ohio three channel-spans of 500 ft. each are required, and, "in addition to the channel-spans prescribed, there shall also be a draw or pivot-span, having at least one opening of 200 ft. clear channel way, located over a good high-water channel, easily accessible by boats at all stages of water over 20 ft. above low water."

In the Illinois River, above Peoria, the channel way is placed at 300 ft., and that whenever it is possible all bridges shall be located over straight reaches, and not less than 3,000 ft. from the up-stream end of the reach.

Companies intending to locate bridges are requested to give two weeks' notice in papers circulating extensively in the contiguous country. Parties owning bridges will also have to maintain, besides the usual lights, a bulletin conspicuously posted giving the depth of water in the channel in letters not less than 2 ft. high. High bridges over the Missouri below the Osage are required to have 3 spans of 300 ft. clear; low bridges over the Missouri below the Osage two openings of 200 ft. clear; high bridges on the Mississippi above Keokuk 3 channel-spans of 300 ft. clear, and low bridges 2 channel-spans of 200 ft. clear.

CORRESPONDENCE.

RADIUS OF GYRATION.

NEW HAVEN, March 18, 1882.

EDITOR ENGINEERING NEWS:

I am sorry that anything I have written should have been interpreted as reflecting upon any class of men, especially upon a class so worthy of admiration and respect, for character and achievements, as the "practical" engineers of America—a class to which, if I am not mistaken, Mr. Editor, you are yourself a worthy ornament. I meant no offense, either to them or to you. I may perhaps be pardoned for thinking that one who could give such shrewd hits would perhaps take in good part as shrewd a "counter," even though it might excite the circulation. I scarcely think, even now, that I was mistaken.

Perhaps the chief difficulty, at least in this part of our discussion, lies in the mutual understanding of the term we use. I speak of the "practical" man, and you speak of the "would-be scientist" in equal terms of reprobation, and, perhaps, we may both be right. Words sometimes get twisted from their original meaning, as your definitions of "wiseacre" show. That, as you say, has a primary meaning which has all but disappeared, while the later and offensive signification remains. So with "practical" man. It is susceptible in common parlance, just now, of two widely different interpretations.

I think I am as little capable of underestimating the "practical" engineer, using the word in its best sense, as you are of underestimating the "theorist," using this word also in its best sense. I certainly am incapable of thinking or speaking slightingly of any honest and *tolerant* class of men. But a spirit of intolerance in any class is reprehensible wherever found, and it was only to such that my remarks were directed.

Few need be told to-day, that the mathematics are only an aid to the reasoning faculties, enabling one to follow out to perfectly logical consequences a train of reasoning which would otherwise elude the grasp of the best trained mind. That they are an instrument only—a means to an end—and that guiding intelligence and reason must ever control the mechanism. "Theory" is thus only the best reasoning of which we are capable, by the use of all those aids which advance in mathematical knowledge has given us, and it should always be just as true as its *data*—neither more nor less. "Practice," when worthy of the name, should always be based upon much reason, whether with or without these mathematical aids, and really differs in fact, as we find it, only in that it does not generally make such use as it might of such aids, or to such an extent as it might. Hence if we are to make any distinction at all, we may say that in general it is not *always* as true as its *data*.

This, in most cases, cannot be helped, because the problems the practical engineer is called upon to solve cannot always be subjected to strict mathematical analysis.

In the validity of the *data* assumed lies then the strength of both, and the only valid reason for any popular distinction between them. Practice built up upon false *data* is only poor theory, and theory, based upon false facts, leads to bad practice. The "practical" engineer, then, is properly distinguished from the "theoretical," if at all, not by his deficiency in analysis, but by the superior accuracy of his *data*, drawn, as they are, from personal experience, and by his superior comprehension of the practical bearings of any given problem. Such a man, it is true, is often found to be deficient in his logical methods, hence the popular distinction.

The "theoretical" engineer, on the other hand, although possessed of superior accuracy in his logical methods, is too often handicapped by the lack of that personal experience necessary for a proper comprehension of the data essential to a given problem. He builds upon the experience of others. The *constructive feeling* of an experienced engineer is often more valuable than his most elaborate investigations.

Now, perhaps in reality we cannot draw such a sharp and clear dividing line as this. The two classes are not so distinct, but merge into each other. Many "theorists" have large practical experience, and many "practical" engineers have considerable mathematical facility. The work of our technical and scientific institutions tends every year to render such distinctions less and less apparent and valid. It will be a happy day for all of us when such distinctions cease to exist at all.

But every "theorist" worthy of the name has learned at least one lesson, and learned it very thoroughly too, viz.: that first assumptions and data must be scrutinized very closely, before he sets the mathematical machine at work; and that he can never afford to forget that every result it grinds out is, after all, based upon an "*if*." If he puts in error, he cannot expect to get out truth.

I think also, that every "practical" man has had good reason to remember that a *formula only holds good under the same practical conditions as those assumed in its development*, and that it can never be safely used except by one who thoroughly appreciates the premises upon which it is based and the method by which it is obtained.

But, Mr. Editor, I think you will agree with me that there are "wiseacres," both young and old, to be found in all professions, not excepting that of engineering; and these "wiseacres" are both "theoretical" and "practical." The intelligent engineer distrusts and dislikes both. You will also, I think, agree that there is, however much we may deplore it, a certain class, to whom the use of "x" and "y" is only mysterious jugglery, to be distrusted; who regard as "wiseacres," in the bad sense of the term, all who use mysterious symbols which they do not understand. I may do you an injustice, but it seems to me that the close of your article in last week's issue is an appeal to the prejudices of just this class. If these men were to see a page of Greek they would admit it might have meaning for those who can read, but when they see a page of mathematical symbols they suspect—what? They could hardly tell; but "why if there is anything there, can it not be put in simple words." Of course it is useless to tell them that the results *are* put into "simple words," and that they themselves use them, often without knowing their indebtedness. To tell them that to write out the whole in "simple words" would involve the best mind in confusion, is to tell them what they cannot understan any more than they could read the Greek page. So they subside into settled distrust and jealousy, really thinking there is a favored class of men who try to air their acquisitions by burying simple facts under heaps of "mathematical rubbish;" charlatans in fact. A veritable battle of "town and gown."

It is but natural there should be many such men in a pursuit which has only of late years been able to class itself as a "learned profession." There will be naturally less of them in the future. Still, it seemed to me that your remarks upon the subject of "*radius of gyration*" were not calculated to reduce the number of this class, and however good your remarks may have been in themselves, they were not suggested properly by the text. That you should make such use of it seems to me to call for notice.

As I understand the question, in view of your last reply, your position is this:

The edition of Rankine you consulted (1864) does not mention radius of gyration in connection with columns. But it does appear in later editions and works by that author. This you give us to understand is mainly in order to furnish *mathematical recreation* to the Glasgow students! Is this fair to Rankine or to the question? And what is its effect on the class I have alluded to?

I find nothing more in your reply which touches the question at issue at all—omitting various "digs" at "*Young America*" and (I suppose) your humble servant, which I trust will be taken by both in very good part, and only call forth wrath from those who find the remarks to "fit"—except toward the close. Here you make the very positive assertion that the use of r^2 isn't a bit better pratically than that of d^2.

Now perhaps you know quite as well as I do that assertion is not proof. I think the use of r^2 *is* better and I *gave my reasons*. I showed also how d^2 comes to be used, and when it is proper to use it and when not to use it. I did not give the mathematical reasoning, but am ready to furnish it, of course, if desired. I showed that you were really taking a *special case* and applying it generally.

You reply in substance: "Rankine isn't a 'wiseacre,' his old '64 edition doesn't mention r^2 at all, and I don't believe r^2 is any good, anyhow."

Now, Mr. Editor, this isn't sound, and any amount of disquisition upon related and non-related topics, including calculus, fluxions, quaternions and quotations from Huxley can't make it so.

You say d^2 will give as "reliable results as any other method." Now, if I may venture again to differ from you without making any pretensions to "vast knowledge," I would say that this *is not so*. At least my calculations do not justify the remark, and I am willing to compare them with yours, and more than willing to be corrected. It is, of course, a question of mere calculation and comparison, and I find that the substitution of d for r in Gordon's formula *does* make considerable practical difference. Moreover, our best practical engineers do not seem to agree with you on this point. In the specifications of the *N. Y., Pen. a. & O.*, the *Cincinnati Southern*, the *Louisville & Nashville*, and in the pocket-book of *Carnegie Bros.*, we find r^2 specified, and I suppose we may infer it is good for something. I pick up the papers referred to as they come to hand on my table. I suppose I could with little trouble, if I had time, give you a full column of such references.

Does all this show anything? Or are we all wrong and has it been reserved for you to find out? Do you really think that all these men, in-

cluding as they do the best bridge engineers of this or any country, are all united in the absurd use of an unnecessary and "complex" quantity which has no real practical utility whatever, just to "show how smart they are," and that it has been reserved for you to show by a casual glance at an antiquated edition of Rankine that they are all wrong and that Rankine himself, like some editors, having once written a thing down "just so," couldn't possibly change it? If so, will you please give us the method by which you arrive at your conclusion, that we may all be convinced?

If not, might I not, had I not forsworn all jocularity, refer to your own definition of a "wiseacre," and ask you, in your own interest, to revise it? For, surely, what constitutes "undue pretension to wisdom," if not the authoritative announcement of conclusions which one cannot sustain? Might I not also ask whether the "complacency" of which you speak is entirely confined to *young America*?

Finally, Mr. Editor, I make no pretensions to "vast knowledge" on this or any other subject, nor have I ever made such pretensions. I have simply done as you yourself did in the first instance, viz., consulted the same authority as yourself (though, as it appears, in a later edition) and have substantiated Rankine's conclusions by those of others, as well as by mathematical analysis, so far as it goes in this question. If the result does not agree with your entirely unsustained opinion, I cannot help it. I must leave it for your readers to decide; and while I regret that my remarks have seemed offensive, I cannot feel that they were entirely uncalled for.

I have, in common with yourself, as much amused unconcern, and, I hope, at least as much charity for the "complacent" enthusiasm and the "refreshing" conceit of "Young America" as yourself. For, after all, these are the natural failings of youth, and time will bring its remedy. But for that intolerance, born of ignorance, which is common to old and young alike, which assumes that what one doesn't know isn't worth knowing, I have not so much. It was against this, and not against yourself or any class of men, I directed my remarks. They seemed to me then, at least, as appropriate as those remarks of yours, which certainly appeared to me calculated to fortify just such intolerance, and which, however good in themselves, the text of "radius of gyration" certainly did not warrant.

Yours very truly,

A. J. Du Bois,

Prof. Eng. Sheffield Scientific School of Yale College.

[We give place with great pleasure to the above under the heading of "Radius of Gyration," from the accomplished professor of engineering in the Sheffield Scientific School of New Haven—not as determining beyond controversy whether the diameter of the least circle within the boundary lines of a given section of a column is a less reliable factor for application in Gordon's formula than the radius of the circle of gyration as proposed by Rankine, but as an able article explanatory of the grounds of difference between the methods of two classes of engineers, each indebted to the other, but more or less indisposed to acknowledge the indebtedness. The harmonious working of the two in a common field is a consummation most devoutly to be wished. The article is commended to our readers as fairly supplementary to our own on Applied Mathematics in the News of the 18th inst. We take exception to but one paragraph in the above, wherein the writer alludes to a seeming appeal on our part to the readily excited prejudices of a class of which we had constituted ourselves the spokesman. He does us scant justice in admitting the possibility of having mistaken our purpose. The closing lines of his own article in No. 9 of the News was with a sneer, not more obviously pointing to a class, in our opinion, than to an individual who has a wholesome horror of remaining long in debt to any one for compliments.—Ed.]

STADIA SURVEYING.

St. Louis, Mo., March 15, 1882.

Editor Engineering News:

There have recently appeared in your valuable paper two articles on "Stadia Surveying," which I have read with a great deal of interest. The stadia does not occupy the place in general surveys that it deserves, and anything that can be said which will bring it into more general use will certainly be a great benefit to the profession.

Attention is called to several statements in these articles which are apt to mislead the novice in stadia work.

While the stadia is the best instrument to use in all topographical work, as well as in many preliminary surveys, it is not claimed that it is strictly accurate, but the errors introduced by its use are so small that they may safely be ignored in work of the character mentioned. It can often be used with a greater degree of accuracy than the chain, and sometimes when chaining is entirely impracticable.

But encumber the stadia with sliding targets, sights to aid in holding it perpendicular to the line of sight, or plumb bobs and watch levels to insure its being plumb, microscopic divisions as a fancied aid in reading the distances closely, and constants, to apply to all readings, and you have almost entirely shorn it of its utility.

On the U. S. Lake Survey and also on the survey of the Mississippi River under the Mississippi River Commission, it has been found by long experience that the best rod for general use is made of well-seasoned pine, is 5 in. wide and 14 ft. long. They are marked as in figure 1 of Mr. Allen's article. The rod is held vertically. In graduating the rod, it has been the custom to distribute the quantity due to $(c + f)$. The space on the rod corresponding to this distance equals about 0.1 in. and is not appreciable at all with the ordinary telescope at a distance of 300 meters, except under unusually good atmospheric conditions.

It is evident, then, that the errors introduced by this method, in the average readings, are too small to even remotely affect the result.

To obviate this supposed difficulty it is suggested that the rod be so graduated that the correct distance will be given by adding a constant to the reading. This is, however, but another approximation, and is true only where the reading is over a level line. When the line is inclined, the true correction will be $(c + f) \times \cos.$ vertical angle.

In the reduction of the work on the surveys above mentioned, the graphical method was long since discarded for tables published by the U. S. Engineer Department. The latter have the advantage of being accurate, and as the quantities are computed correctly, once for all, they are free from the accidental errors so liable to creep into individual computations. They are also much more expeditious than the graphical method. As for "the labor they entail," it may be said that in the surveys mentioned it is customary to have a recorder, who is usually selected from the more intelligent axemen, who records the field notes and has ample time to take out of the tables the elevations of all points given by three stadia men.

In general topographical work the use of targets, and also the plan of holding the rod perpendicular to the line of sight, are both impracticable for several reasons. The rod-man is frequently down in a hollow, behind a ridge or in the woods, where he cannot see the transit man. Many times, in order to have the rod seen, he is obliged to stand on a fence or a stump, and then hold the rod as high as he can. At other times grass, field vegetation, brush, etc., obscure the lower part of the rod, and in the woods it often happens that but small spots of the rod can be seen. It is evident that in such cases holding rod perpendicular to line of sight or manipulating targets are both out of the question. There is no doubt that under especially favorable circumstances, and where greater accuracy is required, targets could be used; but it would be at the sacrifice of considerable time. Holding the rod perpendicular to the line of sight has no advantage to recommend it.

J. A. Ockerson.

THE METRIC SYSTEM.

Boston, March 20.

Editor Engineering News:

The three fundamental principles from which the entire series of decimal weights, measures and coins are derived, have been stated in the first article upon the standard metric chain, and their application to their linear measure was explained in detail.

These principles, which have been called the principles of doubles and halves, are very imperfectly understood, although we have a decimal currency; indeed they are frequently overlooked in elementary treatises upon the metric system itself. It seems proper, therefore, to explain the application of these principles to weights, capacity, measures and coins in order that the simplicity of the decimal system may be more perfectly appreciated.

In common with the measures of length, every measure derived from these principles, whether of weight, capacity, or value, possesses the valuable property that every smaller metric unit of its class is an aliquot part of it, while it is itself an aliquot part of every larger metric unit. Weights, capacity, measures and coins, however, are used in sets, embracing that portion of the entire series best adapted to the purpose in view. A set based upon the principles of doubles and halves possesses some peculiar and valuable properties which have not been alluded to in these articles, and which may be illustrated with weights.

With the units, their doubles and halves, we have the series.

1g., 2g., 5g., 10g., 20g., 50g., etc., comprising the prime factors of 10, and their decimal multiples.

With a 1, two 2s and a 5 we can weigh any individual number of units from 1 to 10 inclusive; adding two 10s, a 20 and a 50, we can weigh any number from 1 to 100 inclusive; adding to these two 100s, a 200 and a 500, we can weigh any number from 1 to 1,000 inclusive, and so on.

We have used in making up this set, the *fewest different kinds* of weights, the 1, 2 and 5 of each denomination; we have employed the *smallest possible number of pieces*, four in each denomination; and the entire set is made up with the *least aggregate weight*, the total being just double the largest weight in the set.

A little reflection will show that the use of other kinds of weights, either in place of the 2 and 5 or in connection with them, will cause a loss of simplicity and convenience.

Sets of capacity measures, also, are composed of the 1, 2 and 5 of each denomination. They do not, however, contain duplicates, it being simpler to use the same measure when a repetition is necessary.

The principles of doubles and halves have been very imperfectly applied to the coins of the United States. This is one reason why these principles are so imperfectly appreciated in this country. The French coins comprise the 1, 2 and 5 of each denomination. The series of U. S. coins is complicated by the introduction of the 3-cent piece, the 25-cent piece and coins of 2½ and 3 dollars. The 2-dollar piece has never been issued.

The great convenience of a set of coins based upon the principle of doubles and halves is illustrated in our paper bills, with which any number of dollars can be made up with the fewest different denominations and the fewest number of bills. When people understand that money can be counted with greater convenience by using only 1s, 2s and 5s, and their decimal multiples, the 20-cent piece will be asked for in preference to the quarter.

This latter coin has retained a strong hold upon the popular mind, because so many articles in common use have been given a price to correspond with it. A moment's consideration of the fact that 25 is only divisible by 5, without a remainder, while 20 is divisible by 2, 4, 5 and 10, will show that the 20-cent piece is best adapted to the details of trade. Were it not for long-established habits, the 25-cent piece would be found as inconvenient a coin as a 2½-cent piece, or the 2½-dollar piece, for the former is merely 2½ dimes.

Enough has been said to show that the *doubles* and *halves* are required by the law of numbers; that is, that in making up 10s, of which the whole decimal system consists, 1s, 2s and 5s are the only numbers that can be used without sacrificing convenience and simplicity.

With one principle governing every class of measures, of length, capacity, weight and value, a measure or weight is furnished corresponding with each coin, and with its fractional parts, reducing the labor of computing prices, or of computing the quantities corresponding to a given price, to the least possible amount.

The metric system furnishes a single series of capacity measures, from the centiliter to the kiloliter, or from 1 to 100,000, each one of which may be exactly expressed in terms of the cubes of the linear measures, the kiloliter being the cubic meter, the liter being the cubic decemiter, etc.

This single series is used for *all commodities, liquid or dry*, thereby abolishing the confusion and incentive to fraud caused by having several measures called by the same name, as is now the case with the quart.

The metric system likewise furnishes a single series of weights, from the milligram to the ton, or from *one to one thousand millions*, each one of which is the weight of the distilled water contained in a corresponding capacity measure, under fixed conditions of temperature and pressure, the ton being the contents of the kiloliter or cubic meter; the kilogram, of the liter or cubic decimeter, etc.

This single series is used in weighing *all substances, solid or fluid*, thereby abolishing the inconsistencies arising from the use of several incongruous systems of weights, such as the avoirdupois and Troy, with which the apparent paradox, that a *pound* of feathers is *heavier* than a pound of gold, while an *ounce* of feathers is *lighter* than an ounce of gold, becomes an actual fact.

The entire system may be stated in a single paragraph:

Measure all lengths in meters, all capacities in liters, all weights in grams, using decimal fractions only, and saying deci for tenth, centi for hundredth, milli for thousandth, deka for ten, hekto for hundred, kilo for thousand, and myria for ten thousand. Surfaces and volumes are measured by the squares and cubes of the measures of length. The arc, the unit of land measure, is merely another name for the square dekameter. It has one multiple, the hektor, and one submultiple, the centar; the former being the square hektometer and the latter the square meter. Similarly the stere, the unit for measuring firewood, is merely another name for the cubic meter. It has one multiple the dekastere, and one submultiple, the decistere. The terms quintal and ton are sometimes used to express 100 kilograms and 1,000 kilograms respectively. The word *ar* is derived from *area*. *Stere* is derived from the Greek *stereos* a solid, but is rarely used, being confined to the measurement of firewood.

There are no complex tables, no complicated relations. With the meter, every possible dimension can be measured, whether of length, surface, or volume; with the liter, every possible capacity;

with the gram, every possible weight. The single paragraph above takes the place of compound or denominate numbers in our arithmetics, and conjointly with the decimal character of the system effects an immense economy in the education of the young. The gain in commercial computations is much more important, for a single operation gives an absolutely accurate result, where the common system requires several complex operations to get an answer which is often but an approximation.

The metric system, by which so much is accomplished, has already been adopted by *thirty* different countries, including some of the most important nations on the globe. In twenty-eight of them its use is obligatory by law. In several, like Germany and France, there are penalties for using any other measures; in others, as in the South American states, in Turkey and in Egypt, the law is imperfectly enforced among the people, but the system is employed in the custom-houses and other business of the governments.

In Sweden its use becomes obligatory in 1883. In British India the compulsory enforcement of the law is left to the discretion of the local governments.

The use of the metric system is permissive in Great Britain, the British Colonies and the United States of America.

Such is the remarkable record of the first ninety years of the history of this system.

With the commencement of active railroad construction in Mexico, the metric system ceased to be simply a matter of sentiment to the engineering profession, and became an affair of practical importance and necessity. Such it will continue so long as the services of engineers shall be required in that country.

Every engineer must, therefore, feel the necessity of becoming familiar with the best methods of using it in actual practice, and it has been the purpose of the writer to furnish, in this series of articles, accurate and reliable information which may assist those who may not have access to the best metric literature, in selecting and using the best implements and methods.

CHARLES H. SWAN, C. E.,
Chairman Committee on Manufacturers,
American Metric Bureau.

MAXIMUM STRESSES.

FAYETTEVILLE, Ark., March 15, 1882.

EDITOR ENGINEERING NEWS:

The following formulæ show the maximum stresses produced in a piece under the action of both a direct force and a transverse load;

Let P = maximum pull in the piece.
P = minimum pull when loaded transversely.
M = maximum bending moment.
A = area, and I = moment of inertia of cross-section.
e = dist. of line of action of direct pull, above the neutral axis.
t = dist. of extreme tensile fiber from neutral axis.
t' = dist. of extreme compressive fiber from neutral axis.

Then the maximum stress per sq. in. in the bottom flange is evidently

$$\frac{P}{A}+\frac{Mt}{I}-\frac{Pet}{I},$$

and in top flange

$$\frac{P'}{A}-\frac{Mt'}{I}+\frac{P'et'}{I}$$

The required areas can be found by trials and approximations.

The method of W. H. Burrall (in ENGINEERING NEWS of March 11, 1882) will give results in agreement with this formula, provided that (1) the lever arm of the addition to the bottom flange is taken, as the distance between the centers of gyration of the flanges, about the neutral axis of the increased section, the web being taken into account in finding the centers of gyration; and (2) that the moment due to eccentricity of the direct force, with respect to the neutral axis, is taken into account; the direct force being assumed to act along the neutral axis of the original section. This may be allowable in a pin-connected member, where the point of application can be located with some approach to accuracy, but in the riveted girder under consideration, where about all that is known is that the force passes through the piece, it is inadmissable to depend on this counteracting moment.

The method of the railroad company's engineer, given by Mr. Burrall, is also open to objection, the material being arranged in a very uneconomical manner. The plates being rigidly connected to the channel webs, the tensile force will be distributed uniformly over the entire area of the member, while the radius of gyration of the plates being smaller than that of the channels, the latter will, of course, carry proportionally more of the transverse load. In other words, the material near the neutral axis distributes its load to the flanges, while it is unable in return to relieve these of the stress due to bending moment. A practical example will make this plain. Suppose a member has to resist a direct tension of 100,000 lbs., and a moment of 360,000 inch-lbs. Two 10 in. channels, 80 lbs. per yard (I net 90) will resist the moment, while two plates, 10 in. × ½ in., say 9.95 sq. in. net, will resist the direct tension. The net area of the combined member is 24.10 sq. in., and the net moment of inertia 261.

Then the maximum stress in the lower flange is

$$\frac{100.000}{24.10}+\frac{360,000\times 5}{261}=11,045 \text{ lbs. per sq. in.},$$

or about 10 per cent. greater than the allowed strain. At the same time the upper flange is needlessly heavy.

The result obtained above, taken in connection with the fact that the strength of shape iron is 10 or 15 per cent. less than that of good bar iron, points to the use of longitudinal floor-beams, independent of the lower chords, when this form of floor is adopted. Yours truly,

JOS. A. BEAUMONT, C. E.

SPIRAL CURVES.

C., C. & I. C. RAILWAY,
OFFICE OF ENGINEER, MAINTENANCE OF WAY.
RICHMOND, Ind., March 22, 1882.

EDITOR ENGINEERING NEWS:

DEAR SIR: It was with much surprise that I read the article in your last issue on "Spiral Curves," which must be very discouraging to the author of the method expounded in the preceding number, and I must take exceptions to most of the article.

If a road only employed a $2 engineer, with a $10 transit, I should say, leave all the engineering to a $1.50 trackman, with straight edge and bar. But is this the case? I can answer for some thousands of miles of the best road in the country—No!

For a second-class road with a few freight and local passenger trains that may be rattled over the road any way so that they get there, regardless of speed or comfort, most any kind of alignment may do, but for a trunk line, where from 50 to 100 heavy freight trains must pass over the same rails every day, and fast express and mail trains must be whirled around 6° curves at 50 miles an hour, too great care cannot be taken with the alignment. It is then that the spiral comes in as a blessing to the weary traveler in the sleeper by guiding the car gradually from a straight to a circular course, while the gradual elevation of the outer rail makes the increasing centrifugal force, scarcely felt instead of, as in case of circles alone, giving the car a shock that nearly turns the sleeping (?) traveler upside down at every P. C. and P. T.

I would ask, is not what is worth doing at all worth doing right? It is no more difficult to run in a curve with spiral ends than it is without them, the error not exceeding 0.10; and then the track may be put in condition to fulfill the conditions required of a track, while a butchered circle never can, as flattening the ends makes another part sharper than the original circle and requiring variations in elevation of the outer rail that the skillful trackman will never give it.

It is not claimed for spiral curves that they reduce the resistance of trains, but it is claimed that for a given speed the centrifugal and centripital forces can, throughout the entire length of the curve, be balanced, while with circles and straight lines it cannot be done.

I am sorry that more conservative engineers should think spiral curves of no practical value whatever, for "Young America" is putting them on the ends of all his curves in many places in this country with very gratifying results. It may be that they were attempted before their time had come, but with steel rail and stone ballast pains may be taken that on a road with old iron and a mud road-bed would have been wasted.

Yours truly, ENG. M. OF W.

[If this easement at the P. T. can be retained in the road-repairing, you have our own experience as evidence that early conviction showed us the desirability of it, but if you have ever been engaged on road repairs, you do not need to be informed that its continuance is impracticable. "It is well to aim high, even though one fails of attainment." A very good sentiment for the school-boy's copy-book, but, in this practical age, will it not serve a better purpose, perhaps, to lower our aim a little, and, after finding absolute perfection unattainable, content ourselves with attaining the *best possible?* The young aspirant for engineering honors should do his whole duty as he understands it, leaving consequences to those who come after him. The uncertainty as to what the result may be should not discourage any refinement of instrumental labor which he has reason to believe as of practical value.]

RECENT INVENTIONS.

A late English invention consists of a rotary motive power engine, the cylinder of which is of annular form. Though its center passes a rotary shaft carrying a circular piston upon a radial arm. The steam is admitted through a valve chest on the outer upper periphery of the cylinder, the slide in which has three ports, the central one leading to the exhaust, and the outside ones passing down to a boss which secures the piston to the rotary shaft, and which is formed with two opposite chambers and ports, passing to the opposite sides of the piston, so that by shifting the valve the engine can be made to run in either direction. The cylinder is divided into two semi-circular chambers by radial slides which are alternately moved to allow the passage of the piston by means of eccentric cams on the rotary shaft.

A new safety attachment for elevators consists of a cable, one end of which is secured to, and combined with, the latching mechanism adapted to arrest the descending cage. The other end of the rope is attached to a weight. A grooved wheel is provided at the top of the elevator shaft, over which the cable travels upon the ascent or descent of the cage. A brake is arranged to arrest or retard the rotation of the grooved wheel, which is operated by the cage, should it, by accident, fall.

A late improved means for clearing the slots of wire-rope railways consists of a supplemental shaft or spindle, which is secured to a car or dummy, and provided with a toothed or cutting and breaking edge upon its inner end, adapted to rotate or move in the slot of a cable railway, with the driving axle of a car or dummy, to which it is geared, and operating in a reverse manner from that of the tread of the wheels of the dummy.

A new telephonic mouthpiece is composed of a diaphragm, the unsupported vibratory area of of which is composed of a flat annulus and a central hemispherical depression.

A novel car spring for railway cars comprises a graduated bolster spring, composed of a group of spirally coiled bars, placed side by side, and in which the spiral or spirals having the greatest bearing and carrying capacity is not acted upon by the load till after the other and weaker spirals of the group have been brought into action, and in which all the spirals under a given pressure shall become solid at the same time.

A new incandescent electric lamp provides the following method for attaining the much sought after perfect vacuum in the inclosing globe or bulb; that is to say, by forming the main bulb of the lamp with two small bulbs having free communication with said main bulb containing the incandescent filament of carbon; placing in one of said bulbs hydrate of potassa and in the other pumice-stone, saturated with sulphuric acid, exhausting and sealing the lamp in the usual manner, and then heating the carbon gradually from a low, red heat to incandescence, and finally sealing the main bulb of the lamp, and removing the small bulbs.

A new engineering structure consists of an elevated railway spanning a canal, with railway tracks supported thereon immediately over the canal. Pipes or conduits for conducting compressed air are arranged in groups on said structure, and other railway tracks supported upon said pipes or conduits.

A novel electric boring drill consists of an electro motor, a drill or stock rotated thereby, and mechanism for alternately advancing and retracting the tool. Electro-magnetic feed mechanism controls said movements. The device is provided more particularly with hydraulic feed mechanism interposed between the motor and tool, a water supply pipe, a compression chamber and valve, an electro-magnet controlling said valve, a gauge included within the electric circuit, and mechanism actuated by pressure in the compression chamber automatically to open or close said circuit, to operate said valve, and thereby regulate the water supply.

A novel telephone system, by means of appropriate switches, has the line battery which is located at the central office, so that it may be connected either through the transmitter or through the secondary of the induction coil to ground, and the transmitter can be put either into the local circuit or in the ground connection.

A new composition for sewer drain and water pipes consists of a concrete composed of coal tar, asphaltum, oxide of iron, sand or gravel, hydraulic cement or calcined plaster, and either with or without oils or salt.

A new system of electrical engineering in the drainage of excavations comprises an electro-magnetic motor, a force pump, a turbine wheel located at a proper distance below the pump, connected therewith by pipes, a dynamo-electric generator, and wires connecting the same with the motor, all being designed for mutual operation. The method by which this apparatus works is as follows: The conversion of the force of the water pumped up into an electric current when the same shall have fallen a distance greater than twice the vertical distance through which it was forced up, then reconverting the current into power and utilizing said power to work the pumps.

WASHINGTON, D. C. F. B. BROCK.

ENGINEERING NEWS.

GEO. H. FROST.....PROPRIETOR.

Tribune Building, New York City.

JULIUS W. ADAMS, *Past President A. S. C. E.*, EDITOR.
S. D. V. BURR. ....ASSOCIATE EDITOR.

SATURDAY, APRIL 1, 1882.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe, $5, payable in advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

Terms of Advertising.—One inch, 12 lines, one insertion, $2; one month, $6.50; three months, $17; six months, $30; one year, $50. Special rate for large space and long time will be given on application. Advertisements inserted for less than three months, payable in advance; for longer time, payable quarterly.

Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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THAT our surmises, as indicated in the article on "The Outlook for Engineers" (issue of March 18), were correct has been shown by the decreased demand and consequent lowering of prices for rolling stock and steel and iron rails. Two weeks since orders could not be placed for delivery this year, even at the high rates then prevailing; while orders now can be placed for delivery in three months. The state of activity in the rolling mills and locomotive works presents an infallible test of the condition of the railroad enterprises throughout the country. One large locomotive establishment has already decided to slightly reduce its working force, and others are contemplating such a step. That the season will be unprecedented for the magnitude and wide-spread character of undertakings by municipal authorities and private individuals is clearly shown in the early commencement of work. Systems of sewerage and water-works are being built, and where now built are being greatly extended, and building operations are brisk in all sections. Money can be obtained at low rates, and, owing to the general confidence now prevailing, is freely put upon the market. Railroad enterprises seem to be the only ones which have run ahead of the demand.

EAST RIVER BRIDGE.

IS AMPLE STRENGTH ASSURED?

Some anxiety and no little speculation has arisen as to the result to be anticipated from the discrepancy to be noted which appears from the measurements and calculations based upon them, of Gen. Newton, who, in pursuance of his official duties, has reported to headquarters at Washington the facts in feet and inches as he found them, descriptive of such parts of this bridge as were susceptible of measurement by him, and the possible changes to be anticipated in its progress to completion. In 1869 a commission was appointed by the Secretary of War to examine and report upon the proposed bridge. Their report, dated May 23, 1869, recommended the following conditions as properly controlling its construction:

"1. That the dimensions and coefficients of stability of the various parts of the structure shall not be reduced below those represented in the papers submitted to the commissioners.

"2. That the center of the main span shall, under no conditions of temperature or load, be less than the prescribed height in the clear above high water of spring tides as established by the U. S. Coast Survey. [The Chief of Engineers, Gen. A. A. Humphreys, to whom the report was made, recommended as the height to be prescribed 130 ft., subsequently fixed by Secretary of War Rawlins at 135 ft.]

"3. That no portion of the enrockments of the pier or tower foundations above the natural river-bed shall project beyond the pier lines as established by the laws of the State of New York.

"4. That no guys or stays shall ever be attached to the main span of the bridge which shall hang between the bottoms chords thereof."

It would appear from Gen. Newton's report that the height in the clear above mean tide under the circumstances of possible temperature and weight named would be but 134.42 ft., instead of the 135 required by law—but we are since informed that the suspenders are provided with a means of still further shortening them 1.25 ft., so that the cable may be adjusted to a height of 135.67 ft., or eight inches higher than need be, instead of seven inches lower. It is proper to remark that Gen. Newton was not in possession of this information at the time of making his report.

There remains to be reconciled the discrepancy between the coefficients of stability, *as represented in the papers submitted to the commission in* 1869, and what results from a computation of dimensions as at present determined upon.

What may have been the dimensions and estimate of weights, etc., submitted to the commission at that date, May, 1869, we have no means at hand for determining. We have newspaper reports from time to time, professing information upon some branch of this subject; but in a close comparison of dimensions, weight and factors of safety, such as this report to the War Department of the United States government calls for, we have no data sufficient to justify us in entering into an independent calculation. It would seem, however, that all the requirements of the United States government, so far as dimension and position are concerned, irrespective of inherent strength, have been complied with, and there remains only a question of—not how far the strength of the bridge is in excess of the weight of the maximum traffic which can by any possibility be brought upon it—and making all needful allowances for deterioration by time and the elements, this excess of strength is ample for the service to which it may be subjected, and so a safe structure for the government to accept; but the question will be, perhaps, does this excess of strength equal the ideal standard assumed as a requisite margin of safety, when the bridge was projected, and which was embraced in the law under which its construction was legalized?

The factor of safety of 5, of which so much use is made, is an entirely arbitrary one, resting upon no theoretical basis, but purely a matter of judgment and a precautionary measure, rendered necessary in view of the increase in the weight and speed of rolling stock, and the uncertainty attending the varied manipulations of a material so universally in demand as iron and steel, under the new conditions of strength and lightness imposed by the more modern structural requirements.

This factor of safety has been largely increased under the circumstances named, wherever such material is called into use to resist permanent tensional strains, etc., and it is customary after estimating these strains to provide a margin of strength of from 5 to 6 times, where formerly it was customary to use from 3 to 4. About 60,000 lbs. to the square inch tensional strain, having been regarded as the average breaking weight of good wrought iron, the tension which would produce a permanent alteration in its length was found to be about 17,800 lbs.; hence the ratio of 17,800 to 60,000, or as 1 : 3.37 was taken to express the proper ratio between the tensional strains caused by load, and the elements of resistance. In the many suspension bridges built on the Continent of Europe years since, and still in existence, this ratio was invariably taken, but we shall refer to but one of them.

The first *wire* suspension bridge of any considerable dimensions ever erected was built at Freiburg, the capital of the Swiss Canton of the same name, in the year 1834. This bridge spans the Sarine River at a height of 170 ft. The length between points of suspension is 870 ft., and until the constructions of Mr. Roebling in this country, was the largest single span suspension in existence.

The 5½-in. cables, of which there were *four*, consisted each of 1,056 wires of No. 18 (French), laid straight as in the Brooklyn bridge, but unlike them, were not laid up in place, but built upon a platform and raised into position, having a versine of 63 ft., nor were they wrapped continuously from end to end, but only at intervals of several feet, so that for over half of the length of the cable the wires are exposed to view. The bridge is without stays or stiffening trusses, beyond that afforded by a wooden trussed hand rail 3½ ft. in height on each side.

The platform is 24 ft. in width for highway travel, of timber, having double cross beams at intervals of 4 ft. 11 in., covered with two courses of planking. The weight suspended, including cables and suspenders, the latter also of 1-in. wire, is estimated at about 400 tons. Among the tests to which it was put before opening for travel was driving 15 pieces of artillery, with 50 horses and 300 men on the platform, and concentrating them at different points; when concentrated as near the center as possible, the deflection of the cables was increased 39¼ inches. A procession of 2,000, with a military band, marched in step repeatedly across the bridge. The published statement of the trial load, as it was called, was as follows: The breaking strain of the wire was 102.427 lbs. per square inch, and it was tested with a total load of 38,410 lbs. to the square inch of cable; or, the coefficient of strength of the cables was .375 of their ultimate strength, and the factor of safety was $\frac{102\,427}{38,410} =$ 2.68. The bridge was built in 1834, and is still in constant use, as most tourists can testify, but probably never has been loaded to within one-fourth of its strength in practice. This illustration is given, not to discredit the custom of adopting the factor of safety of 5 or even 6 for structures in iron and steel, but to show the ideal nature of this factor when applied in disregard of the circumstances of the case. For short iron truss bridges, under the action of modern locomotives, the live load per lineal foot sometimes equals the dead load, and for long spans even, the live load per lineal foot is not safely taken at less than one-half of the weight of structure. It is manifestly proper in such cases, therefore, to provide a margin of strength indicated by a factor of 6; but where the weight of the structure is a large multiple of the possible or live load a smaller factor or margin is proper.

Taking the figures of the engineers, the weight of the river span borne by the cables, including their own weight, is 5,037 tons. The maximum live load, occasioned by loading the bridge from end to end, would give on this span 1,311 tons, and allowing about one-third of this to be borne by the stays, would leave 1,000 tons to be borne by the cables, or the live load is to the dead load borne by the cables as 1 to 5. Accepting the factor of safety as determined by all the computors to be 4.14, let us see what this means in the present case, and for simplicity of calculation call the factor of safety 4 instead of 4.14, and confine our consideration to the cables and the dead and live load borne by them alone. As we understand this expression it means that if this span of the bridge were under its maximum live load of 1,000 tons it would require four times this load in *addition to the weight of four such bridges*, to equal the breaking weight of the cables. To make this clearer: The weight of this span borne by cables is, in round numbers, 5,000 tons, the live load on the cables is 1,000 tons with a factor of 4, the strength of the cables is 5,000 + 1,000 = 6,000 × 4 = 24,000 tons; of this, subtracting the weight of the river span itself, or 5,000 tons, leaves 19,000 tons, or *nineteen times* the greatest possible live load which can be put upon the bridge, would, with the weight of the bridge itself, represent its breaking weight. This is what the factor of safety in this bridge represents, and not that the bridge will bear but four times the maximum live load, as the statement of the President of the Board of Trustees might lead one to suppose. Such portions of the structure as may be exposed to shocks or vibrations have the full factor of 5 or 6, but the cables will never be exposed to such variations of strain, and taken in connection with the inertia of the mass of the superstructure, exhibit an ample margin of strength for all the service which it may be called upon to meet.

LAKE GEORGE WATER SUPPLY.

We took occasion in No. 10 of ENGINEERING NEWS to notice the fact of the introduction in the Senate of the State of New York of the bill to incorporate the New York & Hudson Valley Aqueduct Company for the purpose of supplying the cities and towns on the Hudson River, including the city of New York, with pure water from Lake George, and stated the general features of the project so far as then known. The report of the Chief Engineer, J. T. Fanning, of the results of his examinations, is now before us, and we make such extracts from it as will put our readers in possession of the facts upon which the petitioners rely for securing a charter of incorporation from the Legislature.

Lake George, in Warren County, is some 34 miles in length, and of an average width of 1½ miles, and has a water-shed of some 300 square miles. The level of the lake is 322 ft. above mean tide, and distant by the line of survey 225 miles from the Harlem River. The water-shed of the lake, it will appear, is a little less in extent than that of the Croton River, which, at present, supplies New York City. Of course, there would be no object in bringing its waters to the city, were there no means of increasing the supply beyond that afforded by the shed of the lake alone; but the upper Hudson, above Glen's Falls, drains some 3,000 square miles, and by a dam across the Hudson

River above that point, is made tributary to the lake, rendering the latter in a measure a storage reservoir. The analysis of the waters, both of the lake and the upper Hudson River, are shown favorably in comparison with other waters of city supply. Taking the available statistics of rainfall near that region, the engineer estimates the mean annual rainfall as probably not less than 40 in., and deducting 5o per cent. for various sources of loss, concludes that in the dryest year 7.8 in. would be available for riparian rights and 12.2 in. for storage, and that 1,500,000,000 gallons would represent the daily average which might be calculated upon for city supply. Reviewing the past experience of the city of New York in its consumption of water and its needs for the future, the engineer projects the proposed work for the present at 500,000,000 gallons daily brought into the city. This is secured by an open canal of 60 ft. in width and 13 ft. deep, with a fall of 6 in. per mile; the banks of the canal revetted with stone, and in localities requiring that precaution, paved and even covered with a roofing. The crossing of depressed valleys being effected by means of wrought-iron pipes of 7 ft. diameter. Raising the banks 16 in. is computed as adding to the flow of the canal 100,000,000 gallons daily. As to the value of the supply for power or otherwise on the line of the canal following the east side of the river valley the heights at various points are stated as follows: Elevation of Lake George, 322 ft.; elevation opposite Troy, 286 ft.; elevation opposite Albany, 283 ft.; elevation opposite Hudson, 268 ft.; elevation opposite Poughkeepsie, 248 ft.; elevation opposite Fishkill, 241 ft.; elevation opposite Peekskill, 229 ft.; elevation opposite Sing Sing, 222 ft.; elevation opposite Yonkers, 213 ft.; elevation at Harlem River, 200 ft.

From the terminus of the canal near High Bridge the water will be conveyed into the city by iron pipes, which may be extended to Jersey City, or, indeed, by the same method any towns or cities along the valley of the Hudson may be supplied; the approximate estimate of the cost being for 210 miles of canal $26,250,000; seven miles of tunnel, $4,900,000; ten miles of syphon, $10,000,000; and the Hudson dam and canal, land and water rights, etc., engineering and contingencies, $8,125,000, or a total of $49,675,000. The favorable circumstances in connection with the location of the line, and the facilities for transportation of labor and material, both by water and railroad, it is expected, will limit the time required for the completion of the work to that necessary for the most difficult portion of it, say the tunnels—or about three and a half years. From the census statistics of the State for 1875, it appears that nearly 40 per cent. of the population of the State in the thirty towns on the river, may be more or less benefited directly by the construction of this canal.

The report of the engineer is systematically arranged and discussed with ability under the following heads, and referring to diagrams of sections of canal and general map of the country: Altitudes of the Lake Waters. Availability of the Water-shed. Available Volumes of Water. Quality of the Water. Quantity of Water Required in the City. Method of Construction. Estimate of Cost. Time Required for Construction. Extended Usefulness of the Water. Statistical Tables. Unless by copious extracts, too extended for the present article, it would be difficult to do justice to the report, which goes less into the engineering problems to be solved and the methods in detail for their solution, than to the general principles involved, which, in the opinion of the petitioners, justified their application at this time for legislative authority for the construction of the work. A brief recapitulation of the bearing of the proposed work on the future of this city and the valley of the Hudson is shown, however, and we quote from it as follows:

"In recapitulation it will be observed that we have shown that the waters of Lake George and the Upper Hudson may, by the use of a short tunnel, be made available—that they may be conducted by an even flow throughout the year by a canal to New York City, and by pipes to the remaining cities of the harbor and the Hudson Valley—that they have sufficient altitude to reach New York City with approximately 200 ft. head above tide-water—that Lake George, as it is intended to develop it, will equalize the flow of 1,500,000,000 gallons of water daily, a supply for 10,000,000 people, without injury to existing water rights—that the water is of exceptional purity, and the conditions are favorable for the maintenance of the purity of the water—that 500,000,000 gallons of water can be brought down to the cities within about three years, and that the capacity of the canal may be readily and cheaply increased as the requirements of the city increase.

"As respects the city of New York, it has been shown that an abundant supply of water and increased pressure will encourage new manufacturing and commercial enterprises in the city, improve the sanitary conditions, more efficiently protect life and property from fire, relieve the citizens of the annoyance and expense of pumping their individual supplies to disease breeding tanks for domestic use, give them hydraulic passenger elevators in their commercial and domestic buildings, give them pure and sweet water to drink all the year round, supply their park lakes and fountains, and public drinking fountains, and thus in many ways tend to enhance the comfort, safety and health of the citizens in household, office, shop and public park, and develop the wealth-producing resources of the city. Beyond this it will give the cities along the Hudson that desire to avail themselves, all the advantages of a pure and abundant water supply that any city of America enjoys, it will give aid and impetus to the development and occupation of the manufacturing sites along the shores of 150 miles of navigable channel of the Hudson River, it will indirectly augment the ratable value of the State, and it will become a powerful incentive to a rapid development of the commonwealth into a magnificent future.

"While New York City is incumbered, as at present, with a bonded debt exceeding one hundred and thirty-five million dollars and net debt of ten per cent. of its total valuation of real and personal property, it is probable that a majority of her citizens will conclude, as you have done, that it is not now expedient for her to undertake so great an enterprise as is herein proposed for the benefit of herself and her sister cities, or even so much of an undertaking as now seems necessary for her own preservation; but the work is a legitimate object for private enterprise, and results have sometimes proved, in similar examples of less magnitude, that private enterprise succeeds in negotiating for necessary water rights and land and executing necessary works with more marked economy than public officials.

"The income in the year 1880 from water rents from pipes already laid in the several cities named that may avail themselves of a supply of water from the proposed works exceeded three million dollars, and the annual income may reasonably be expected to be considerably enhanced by the increased demand for a superior and ample supply of water with increased pressure, so that if you shall be able to make reasonable contracts for furnishing this water you may expect a fair remuneration for your outlay at the outset, and a continually augmenting income as the demand for water increases with the growth and development of the several municipalities."

THE IRON TRADE.

The output of iron and steel is apparently steadily increasing, as is evidenced by the increase of furnaces in blast and the increased production of those already in blast. The announcement of new rolling mills projected or under construction is frequent. A half-dozen are now under way in Pennsylvania, and, perhaps, as many more are projected. A falling off in railroad enterprise, or poor crops, either or both, will dampen enterprise in iron making. Railroad stocks and bonds are at present in excess of demand, and hence an unfavorable impression has gone abroad, which, in some directions, has brought about a restriction of operations. It is as well that a check should be placed upon railway enterprise by prudence. The legitimate necessities of the country are expanding very rapidly, and to provide for them will call into use all our present productive capacity.

There has been very little failure among buyers of railway material to take and pay for material ordered. In fact, there has been very little retracing of steps taken in construction. West of the Mississippi there was some undue activity, arising out of efforts of one set of capitalists to anticipate another set. The consolidation of these interests into the Gould system has led to a relinquishment of the construction of some contemplated mileage. Apart from this, enterprise has not been seriously checked. The difficulty, and, in fact, impossibility of obtaining rails, and other material, including rolling stock and motive power, has retarded construction here and there. Besides this, contemplated repairs have been postponed in some cases. The investing public, who have the utmost confidence in our railway system, and who have, perhaps, too little fear of too much mileage, demand a system of railway management which will make investments more secure, and which will, if possible, give stockholders more control of their property than they now seem to possess. Manufacturers of rails, locomotives and rolling stock have had very few intimations of declining activity in railway construction, although there are undoubtedly causes at work, which, if unopposed or nullified, will in time produce evidences of the fact in diminishing orders. The rush of emigrants continues. The movement of population from the Eastern States to the Western has been lessened by the increasing industrial activity; yet, there is an increasing necessity for new roads west.

The Bessemer mills now control the American demand. Contracts have been recently entered into for steel rails under $55 per ton, and requirements of great magnitude are now under consideration for winter and spring delivery. The ordering of rails abroad has practically ceased, except for one or two localities, where foreign freights are lower than freights from American mills. At present home rails can be furnished at mill $5 per ton cheaper than foreign rails can be delivered at tide. Competition may lessen this figure, but increasing capacity here may still further reduce home quotations.

The various other branches of the iron market are in a healthy condition. Mills are generally crowded with orders, though for shorter times than a few months ago. Supply has virtually overtaken demand, and hence consumers do not feel it necessary to order more iron than they require. The spring demand is backward, not because of declining consumption, but because of fears that between increasing output at home and the possibility of imports, consumers expect to buy cheaper by delay. An ultimate decline in iron and steel is inevitable, but an urgent demand is keeping the tendency in check.

Tariff legislation is progressing slowly. The proposed reference of the entire matter to a commission will prevent ambitious persons from gratifying selfish persons to make political capital, but it will meet the views of the great body of the people, who desire to see impartial legislation enacted.

PERSONAL.

MR. O. E. FARNSWORTH, formerly of the Missouri Bridge Company and a large contractor for bridges on the Omaha extension of the Missouri Pacific, died recently at Doniphan, Kansas.

W. W. COE has been appointed chief engineer of the Norfolk & Western Railroad; headquarters at Roanoke, Va. On the same road George Hoffman has been appointed engineer maintenance of way, with headquarters at Lynchburg.

MR. JAS. H. HANDYSIDE, formerly of the contracting firm of engineers of W. R. & I. Handyside, later managing director of the Ogereff Works, Russia, and for the last thirteen years managing director at the works of Thomson, Sterne & Co., Glasgow, died in that city recently at the age of forty-six years.

GENERAL MANAGER ODELL and Chief Engineer Graham, of the Chicago, Texas & Mexican Central Railroad have tendered their resignations for reasons not made public. Rumor has it, however, that legal proceedings are to be begun against the company in the interest of creditors who desire the appointment of a receiver.

MR. THOMAS AVELING, the senior partner of the firm of Aveling & Porter, the well-known manufacturers of steam road rollers, died March 7 at the age of 58 years. Mr. Aveling was a member of the Institution of Civil Engineers, and also of the Institution of Mechanical Engineers, and of the Iron and Steel Institute.

UNITED STATES AWARDS AT THE VENICE EXHIBITION.

Gen. Wright, Chief of Engineers, has received a report from Captain George M. Wheeler, delegate of the United States to the Geographical Exhibition and Congress at Venice, showing that the following awards were made to the United States:

Class 1 (Mathematical Geography, Geodesy and Topography).—First, Corps of Military Engineers, for the completeness of its works.—Letter of distinction. Second, Geographical survey of the War Department, for completeness of works.—Letter of distinction.

Class 2 (Hydrography).—Third, Treasury Department, Coast and Geodic Survey, for its work relative to the Gulf of Mexico.—Letter of distinction. Fourth, Navy Department, for the completeness of its works.—Letter of distinction. Fifth, Treasury Department Lighthouse Board for publications and charts of lighthouses.—Diploma of honor of the first class.

Class 3 (Physical Geography, Meteorology, Geology, Zoology and Botany).—Sixth, War Department, for completeness of works. Given more especially on account of publications of geological explorations of the 40th parallel.—Letter of distinction. Seventh, War Department, United States Geographical Survey, for the completeness of its works.—Letter of distinction. Eighth, War Department, Meteorological Bureau and Signal Service, for tri-daily weather charts from November 1, 1871, to December 31, 1879.—Letter of distinction.

Class 7 (Commercial and Statistical Geography).—Ninth, Post-Office Department, for publications relative to the service of the post-office, postal charts, laws and regulations, guide reports, &c.—Letter of distinction. Tenth, Commissioner of Agriculture, for annual reports.—Diploma of honor of the second class. Eleventh, Bureau of Statistics, for the completion of its works.—Honorable mention.

Class 8 (Explorations and Surveys).—Twelfth, War Department, for its various explorations.—Letter of distinction.

Letters of distinction were the highest awards conferred, diplomas of honor and honorable mention following successively.

THE TEMPERATURE OF TUNNELS.

Observations in shafts, mines and borings show that at a certain depth (about 29 meters) below the surface the temperature is the same all the year round. The exact law as to increase of temperature beyond that depth is not known; it is assumed, however, that it rises from 0.03 to 0.033

degree C. for each additional meter of depth, consequently by 1 degree for every 30 to 33 meters of depth. Special circumstances, such as the influx of warm water, decomposition of gravel and feldspar, slow combustion of coal, etc., may, naturally, involve changes in certain places. Thus, in the celebrated Comstock mines, Nevada, a temperature of 40 to 50 degrees C. prevails at a depth of 600 to 800 meters. But the depth reached by mines is by no means so great as the height of the mountains superincumbent upon the tunnels which are passing under the Alps, or are to be made through them. Fortunately, the above increase of temperature does not take place in tunnels, but stands in relation to observations in plains or on mountains of medium height. The Mont Cenis Tunnel, for instance, at its center is about 1,350 meters above sea-level; the highest part of the moutain chain below which it runs is 1,600 meters higher. The prevailing temperature there is for the air, 6 degrees C.; for the mountains, 1 degree C.; the temperature observed in the tunnel shortly after its completion was 29½ degrees C., making a difference from the summit to the tunnel center of 30½ degrees C. Thus, the increase of temperature would be 1 degree C. to about 52 meters depth under the mountain chain. We possess very exact scientific observations on the temperature of the St. Gotthard tunnel. The influence of the outer temperature is felt for only 2 to 3 kilometers in the tunnel; thence the temperature depends upon the mass of the overlying rock. In the center of the tunnel, 1,154 meters above sea-level, the temperature is 30½ degrees C.; on the summit, 1,700 meters higher — 1 degree C. M. Dubois-Reymond, who assisted in making observations in the St. Gotthard tunnel, came to the conclusion that work may be carried on just as easily in a dry atmosphere of 50 degrees C. as in a moist atmosphere of 40 degrees C.; those two figures forming the limits within which man is able to work for any length of time.

ENGINEERS' SOCIETIES.

ENGINEERS' CLUB OF PHILADELPHIA.

RECORD OF REGULAR MEETING.

March 18, 1882.

President Rudolph Hering in the chair. Twenty-two members and three visitors present.

President Rudolph Hering presented notes on the Resistance to Traction on Streets, giving results compiled from various authors who had experimented on the subject. Resistance varies nearly as the weight, being great for heavy loads and almost nothing for light pleasure carriages. It increases on paved streets with the velocity and as the diameter of the wheels becomes less. The width of tire has little influence on hard and smooth roads, especially for light loads, while it has considerable influence on soft and rough roads, particularly when the load is heavy. The most economical conditions for traction, therefore, are a hard and smooth surface, large wheels and broad tires; the latter for heavy loads drawn on rough roads. To draw a load on sand requires a power equal to ⅓ its weight, on ordinary earth $\frac{1}{10}$, on hard clay $\frac{1}{20}$, on ordinary cobble-stones $\frac{1}{30}$, on good cobble pavements $\frac{1}{50}$, on ordinary Belgian blocks $\frac{1}{70}$, on London blocks $\frac{1}{90}$, on asphalt $\frac{1}{133}$, and on iron rails $\frac{1}{240}$ of the load.

The economy in horse-power obtained by using the hardest and smoothest roads is clearly shown. If one horse can just draw a load, on a level, over iron rails, it will take 1⅔ horses to draw it over asphalt, 3⅓ over the best Belgian, 5 over ordinary Belgian, 7 over a good cobble-stone, 13 over a bad cobble-stone, 20 over an ordinary earth road and 40 over a sandy road.

Mr. D. H. Shedaker exhibited a large and very complete work on "The Art of Surveying," by John Wing, published in 1699, and presented report of Mr. Heber S. Thompson, Engineer Girard E-tate, upon the extinguishment of the fire at Kehley's Run Colliery.

Mr. W. S. Auchincloss exhibited his averaging machine, which consists of a stand with two uprights which support a rectangular pan 29 in. long and about 10 in. wide. The edges of this pan are formed of tubes, which slide through the bearings and inclose rods forming counterweights. These rods are connected by pulleys with the pan so that, when it is moved in one direction, they move in the other and so preserve the equilibrium.

The pan is divided into equal grooves at right angles to its length.

Paper scales, graduated for various uses, accompany the machine, and the adjustment is so accurate that the absence of a scale, which forms part of the balanced weight of the pan, throws the machine entirely out of balance. A convenient series of weights is provided to compose the quantities to be averaged. We place these in grooves opposite their appropriate points on the scale, slide the pan until in equilibrium and read the average at once from the scale, at the point of support.

This machine was designed especially to average commercial accounts, and can solve 100 accounts per hour and work both sides of ledger at once; but it is also adapted to ascertain average haul of earth, speed of pulleys, etc.

The Secretary presented a description of Defenbach's rail joint.

HOWARD MURPHY,
Secretary and Treasurer.

MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

The third annual meeting of the above association was held at Lansing, Mich., on the 10th, 11th and 12th of January last, and the Proceedings, in a printed pamphlet of fifty-six octavo pages, are just received. There are 114 members. The officers for 1882 are: Prof. Chas. E. Greene, of Michigan University, President; nine vice-presidents representing each of the State Congressional Districts: Prof. R. C. Carpenter, of the State Agricultural College at Lansing, is Secretary and Treasurer; and there are also an Executive Committee, a Special Committee on Manual, and a Special Committee on Legislation.

The Proceedings grows in value with each number, and already those published form a most valuable compendium of information for practical land surveyors, while there are several papers of value to civil engineers. The papers published in the present Proceedings include A Bill to Establish a Board of Commissioners of Surveys (heretofore published in ENGINEERING NEWS); Foundations and Piers of the Wheeling & Lake Erie R. R. Bridge across the Maumee River at Toledo, Ohio, by Prof. Charles E. Greene; Water-Works for Small Cities, by G. W. Pearsons, C. E., of Kansas City; Construction of the Michigan Reform School for Girls at Adrian, by Burton Kent, Superintendent of Construction; Compass Deviations on Vessels and the Conversion of Compass Courses, by H. C. Pearsons, U. S. Inspector of Steam Vessels; Drainage Engineering, by Prof. R. C. Carpenter; Practical Questions in Land Surveying; Subdivision of Sections; Horizontal and Vertical Distances without the Use of a Vertical Arc or Stadia Wires, by H. C. Pearsons, and a Table of Variations of the Needle. The papers are written by men well versed in both theory and practice, but are prepared with a view of being so easily comprehended as to be of daily use to the average surveyor or engineer.

The secretary, in opening his report, makes the cheerful remark that "the present winter has been one of the most favorable for active surveying and engineering work ever experienced in the State;" and of the society he remarks that "this association is the only bond of union between individual surveyors and engineers of our State; it affords to them a means of mutual acquaintance, of education, and finally constitutes an organized body which can be made to exert a great influence in securing desired legislation. The aim is to compactly unite all civil engineers and surveyors, whatever special branch they may follow; and to secure that end, matters of interest to each particular profession will receive attention at the regular meeting." The pamphlet is for sale at twenty-five cents, and can be had of the secretary, Prof. Carpenter, at Lansing, Mich.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

Continued from page 100.

CCLI.—SCRANTON.

Scranton, Pennsylvania, in lat. 41° 23′ N., long. 75° 39′ W., is on both sides of a wide valley through which flow the Lackawanna River and Roaring and Stafford Meadow brooks.

Settled in 1788, it was incorporated as a borough in 1856 and as a city in 1866.

Water-works were built for a private company in 1857 by Joseph Battin, taking the supply from the river by pumping. In 1866, the sulphuric acid in the mine waters draining into the brook polluted the supply to such an extent that the source was changed to a reservoir on Roaring Brook, 4½ miles from the city and 400 ft. above the Lackawanna River, or 300 ft. above the general level of the city.

In 1871 the works were enlarged and rebuilt after the plans and under the superintendence of C. E. Judson, C. E.

Water is taken from a mountain lake of 196 acres area, with one square mile of water shed, 19 miles from the city. It contains 300,000,000 gallons. The water flows from it through the channel of Roaring Brook, on which a storage reservoir is formed 4½ miles from the city, by a dam of stone masonry 320 ft. long and 35 ft. high, 8 ft. wide at top and 22 ft. at bottom, except for 100 ft., which is 35 ft. wide. The upstream face is vertical and the lower face batters 1 in 3. The spillway, 100 ft. long, is stepped on the face with cut stone.

The water-shed above this dam is 18 miles long and 2½ miles wide. The reservoir holds 80,000,000 gallons. The water is passed through a sand and gravel filter into two lines of 16-in. cast-iron pipe, which convey it to the distribution. Pressure is equalized by a reservoir of 1,000,000 gallons capacity, 200 ft. above the distribution level, and a wrought-iron stand-pipe 4 ft. in diameter, with an overflow. The ordinary pressure maintained in the mains is 50 lbs. per square inch, which can be increased to 125 lbs. by making direct connection with the high reservoir.

Distribution was at first by wrought-iron and cement pipe. Cast-iron pipe is now used, and has been largely substituted for the other in the old mains. There are now 29¼ miles of pipe in use, with 106 fire hydrants, 211 gates and 1,047 taps. The city pays $3,000 per year for public supply.

Service pipes are of lead and of galvanized iron.

The population in 1880 was 45,850, and the daily consumption 5,000,000 gallons.

The Gas and Water Company has a capital of $456,000. The works for supplying both gas and water have cost $680,000. No further financial statements are furnished.

The positions of superintendents and engineer have been filled by John Merrifield, Charles Fuller, Henry Battin and the present incumbent, C. E. Judson.

CCLII.—YREKA.

Yreka, California, in lat. 42° N., long. 120° W., is in the heart of the Rocky Mountains. Settled in 1851 it was incorporated as a village in 1855. Water-works were built in 1861 by private enterprise, collecting the water of a number of springs by a wooden trough 8 in. square, with a fall of 1 in 200, and leading it to a wooden tank holding 60,000 gallons, and situated from 22 to 50 ft. above the town. The water is conveyed from the cistern half a mile through bored pine logs of 6-in. diameter and distributed through 4-in. cast-iron pipe. There are 12 fire cisterns and 96 taps. The town does not pay for use of water.

The population in 1880 was 1,500, and the daily consumption 60,000 gallons.

The works cost $10,000. No further financial statistics are given.

Henry Scheld is the Manager.

CCLIII.—CHELSEA.

Chelsea, Massachusetts, in lat. 42° 24′ N., long. 71° 1′ W., is on the Mystic River, opposite to Boston. It was settled in 1738, and incorporated as a city in 1857. Water-works were built by the city in 1867, after the plans of T. E. Ames, and under superintendence of William A. Williams. Water was taken from Mystic Lake, under a contract with the city of Charlestown, which at that time controlled the lake. The works at the lake, now owned by the city of Boston, were described in ENGINEERING NEWS of April 2, 1881. The distribution in Chelsea is by 23½ miles of pipe, of from 16-in. to 3-in. diameter. The first pipe laid were of wrought iron and cement. The extensions since 1875 have been of cast iron. There are in use 136 fire hydrants, 228 gates, 4,171 taps and 47 meters. The city pays for use of fire hydrants, $28 for each 350 inhabitants. Lead service pipes are used. The population in 1880 was 21,783, and the daily consumption was about 1,000,000 gallons.

The works have cost $354,211, or exclusive of interest on the debt of $200,000 at 6 per cent.

The cost of maintenance in 1880 was $4,938.05, and the interest on bonds and on pipe across the Charles River was $14,330.42. The receipts were $12,210.68.

The works are managed by a board of three commissioners. Caleb Lombard is the general agent.

CCLIV.—PETALUMA.

Petaluma, California, in lat. 38° 18′ N., long. 122° 37′ W., is on Petaluma Creek, at the head of navigation, 10 miles from San Pablo Bay, in a valley surrounded by hills. Settled in 1852, it was incorporated in 1857. Water-works were built in 1872 for a private company by M. J. Miller, after the plans of Thomas Bros. The supply is taken from mountain streams, draining 20 square miles. A 7-in. riveted wrought-iron pipe conveys the water to a reservoir 150 ft. square, in excavation and lined with brick, holding 2,000,000 gallons at 175 ft. above the town.

Distribution is by cast-iron and some riveted wrought-iron pipe. Twenty-five miles are laid, with 13 fire hydrants, 8 gates and 650 taps. The town does not pay for hydrants. The population is 4,000. The consumption is not known.

The capital stock of the company is $150,000. The works have cost $130,000, and the receipts so far have amounted to $94,000. There is no debt.

The expenses in 1880 were $4,800, and the receipts $12,700. F. W. Lougee is the Secretary and Superintendent.

CCLV.—TORRINGTON.

Torrington, Connecticut, in lat. 41° 50′ N., long. 73° 12′ W., is on a small stream, in a broken and rocky country. It was settled about 1800.

Water-works were built by a private company in 1878, after the plans of William B. Rider, taking the supply from the stream, which drains about 8 squire miles.

An earth dam, 234 ft. long and 20 ft. high, with rubble masonry heart wall, 8 ft. wide at bottom

and 3 ft. at top, forms an impounding reservoir of 5¼ acres area, and holding 18,000,000 gallons at 175 ft. above the town.

The water is filtered before entering the distribution pipes, by being passed through charcoal and then through sponge, with satisfactory results.

Distribution is by cast-iron pipe, of which 5½ miles are laid, with 25 fire hydrants, 37 gates and 250 taps. The population in 1880 was 2,998. The consumption is not given.

The capital stock of the company is $40,000. The works have cost $32,000, and there is no debt.

The expenses in 1880 were $500, and the receipts $3,100. C. L. McNeil is the Secretary and Treasurer, and O. R. Fyler the Superintendent.

CCLVI.—OTTUMWA.

Ottumwa, Iowa, in lat. 41° 2′ N., long. 92° 23′ W., is on the Des Moines River, which at this point has a fall of 10 ft. in half a mile, affording a water-power which has been utilized by the construction of a dam and race, built by Edward Ruger, C. E.

The town was settled in 1844, incorporated as a village in 1851, as a city in 1857, and reorganized in 1868.

Water-works were built in 1878 by a private company, which made a contract with the city to complete the water-power and furnish water for domestic and fire purposes. The works were designed by S. L. Wiley, and built under the superintendence of E. C. Cooke, C. E.

Water is conducted from the river through a canal 4,000 ft. long and 40 ft. wide, to a settling basin 220 by 180 ft. From this it passes through a filter of brick 20 by 22 ft., containing several screens filled with animal charcoal. This is stated to be capable of filtering 3,000,000 gallons per day.

From the filter the water passes through 400 ft. of 20-in. wrought-iron pipe to the pump-well, whence it is lifted 204 ft. by two Flanders water-power pumps and one Knowles steam pump, to a reservoir holding 2,500,000 gallons, and 204 ft. above the city.

Distribution is by 10 miles of cast-iron pipe of from 16 to 4-in. diameter, with 76 fire hydrants, 37 gates and 390 taps. Six meters are used. The city pays $82.50 per year for each hydrant. The population in 1880 was 9,018, and the daily consumption 1,000,000 gallons. Financial statistics are not given.

W. F. McCue is the Superintendent.

CCLVII.—LAFAYETTE.

Lafayette, Indiana, in lat. 40° 26′ N., long. 86° 55′ W., is on the Wabash River, on rolling ground.

It was incorporated in 1825.

Water-works were built in 1876, by the city, after the plans of Henry Earnshaw, C. E., taking the supply from the Wabash River and pumping it by two Clapp and Jones steam engines, with 25-in. steam and 10-in. water cylinders of 34-in. stroke, into a reservoir 225 ft. above low water in the river, 60 by 120 ft., built of earth embankment above the natural surface. The inner slopes are puddled with clay, on which is laid a pavement of cobble stones, grouted with cement. The bottom is covered with 1 ft. of concrete.

The 16-in. force main, 10,000 ft. long, is connected with the distribution mains and terminates in a stand-pipe of 24-in. diameter and 72 ft. high, in the centre of the reservoir. Water is pumped at will into the reservoir, into the distribution direct, or into the stand-pipe, which is used to furnish fire pressure to the higher part of the city.

Distribution is by 16 miles of cast-iron pipe, with 150 fire hydrants, 102 gates and 802 taps.

The population in 1880 was 14,860. The consumption is not given.

The works cost, to 1878, $266,682.97.

The bonded debt is $300,000 at 8 per cent. interest.

The expenses in 1880 were $11,179.85 and the receipts $11,506.33.

The works are managed by three Trustees.

R. B. Wallace is the Superintendent.

CCLVIII.—MISSION SAN JOSÉ.

Mission San José, California, in lat. 37° 20′ N., long. 121° 50′ W., was settled by the Jesuits about 1775. Water-works were built by J. Keene and J. W. Coleman about 1870, taking the supply from two springs, the water from which is conveyed 4,000 ft. in a brick drain 2 by 4 in. in the clear, to a concrete tank 30 ft. in diameter and 10 ft. deep, on ground 40 ft. above the highest part of the town. Distribution is by 3,000 ft. of 3-in., 2-in. and 1¼-in. wrought-iron pipe, with 32 taps. There are no fire hydrants. The daily consumption is about 20,000 gallons.

The cost of the works is not given. The cost of maintenance in 1880 was $40, and the receipts $600. P. L. Merritt is Superintendent and agent for the proprietors of the works.

CCLIX.—COVINGTON, KY.

Covington, Kentucky, in lat. 39° 5′ N., long. 84° 28′ W., is on the south bank of the Ohio, at the mouth of the Licking River, on nearly level ground.

It was incorporated as a village in 1815 and as a city in 1834.

Water-works were built by the city in 1870, after the plans of Birdsall Holly and under the superintendence of William C. Weir, C. E.

A wrought-iron tube 18 ft. in diameter and 71 ft. high was sunk through the gravel on the river bank. In the bottom of this well 35 3-in. perforated pipes were driven 12 ft.

Sixteen feet above the bottom of the well, a plate-iron floor was placed, on which rested two piston engines and one rotary engine, of the Holly pattern, driving a "gang" of 12 piston pumps and 2 rotary pumps.

The well failed to furnish sufficient water some years ago and the supply is now taken direct from the river by a 20-in. pipe. The rotary engine and pumps have been removed and piston pumps substituted and a McGowan pumping engine added.

The water is pumped directly into the mains, with an ordinary pressure of 60 lbs. and fire pressure of 100 lbs. per square inch. Distribution is by 24 miles of cast-iron pipe of from 20 to 4-in. diameter, with 215 fire hydrants, 35 fire cisterns, 75 gates and 1,998 taps. Three meters are in use.

The population in 1880 was 29,720 and the daily consumption 500,000 gallons.

The works have cost $500,000. The expenses in 1880 were $25,000 and the receipts $30,000. W. H. Glore is the Superintendent.

CCLX.—WESTFIELD.

Westfield, Massachusetts, in long. 72° 25′ N., lat. 42° 6′ N., is on flat land along the Westfield River. Settled in 1658, it was incorporated in 1669.

Water-works were built by the town in 1874, after the plans and under the superintendence of L. F. Root, C. E., with Shedd and Sawyer as consulting engineers. The supply is taken from Moose Meadow Brook, which has a water-shed of 4 square miles.

An earth dam with stone masonry heart wall, 350 ft. long, 30 ft. high, and 8 ft. wide at bottom, and 2 ft. at top, creates a storage reservoir of 38 acres area and 184,000,000 gallons capacity. A waste channel 20 ft. wide was excavated around one end of the dam. This is paved with stone, and has cut-off walls across its bottom. A 6-in. pipe at 5½ ft. below water level, and a 20-in. pipe at the bottom, extend through the dam. This reservoir is 918.63 ft. above sea level, and 771.38 ft. above the town.

The water flows from this reservoir through the rocky channel of the stream to Tekoa reservoir, formed by building a masonry dam 193 ft. long, 14½ ft. thick at bottom, 7 ft. at top, and 29 ft. high. Another wall is built across the bottom of the ravine 50 ft. above the dam, and the intervening space filled with puddle. Two openings enable water to be drawn 5 or 15 ft. below the surface. This reservoir has 1½ acres area, and holds 4,000,000 gallons, at 292 ft. above the town.

A 14-in. cast-iron pipe conveys the water 4 miles to the town, passing under the Westfield River in a trench excavated in the rocky bottom. There are 21 miles of cast-iron distribution pipes of from 14 to 4-in. diameter, with 116 fire hydrants, 105 gates and 787 taps.

The population in 1880 was 7,641. No record is kept of the consumption.

The works have cost $250,000, which is also the amount of the bonded debt, bearing 6 and 7 per cent. interest.

The receipts have been $56,856. The expenses in 1880 were $1,300, and the receipts $9,281

The works are managed by three Water Commissioners. W. S. Bush has been the Superintendent since 1876.

THE GUIDET PAVEMENT.

(Correspondence of the Brooklyn Eagle.)

WASHINGTON, March 15.

To-day, for the first time in her history, Brooklyn came before the Supreme Court of the United States as a litigant. It was in the case of Charles Guidet against the City of Brooklyn. George Harding appeared for the apellant, and Messrs. George Gifford and William C. DeWitt for the respondent.

The case involves the validity of the patent held by Guidet—a kind of stone pavement now lying on Broadway, New York, and on Fulton street, Brooklyn. He claims that his patent has been infringed by the City of Brooklyn in the construction of a similar pavement on Myrtle, Atlantic and Lafayette avenues, Henry street and other thoroughfares.

The cost of laying the pavement on Fulton street was something over seven dollars a square yard, while, after the rejection of the patent by the city, the same kind of a pavement was laid at a cost of less than three dollars per sqnare yard under a general computation. The pavement is considered the best style of pavement for populous cities that has yet been put in use, and the question of whether it can be laid by free competition or shall be controlled under a patent is of the utmost importance to all cities lying near the vicinity of the common rock of formations from which the stone is quarried.

Should it go against Brooklyn, the damages to be recovered by Guidet under the liberal rules governing patent rights, and in view of the extensive use, irrespective of the patent, would amount, it is believed, to several hundred thousand dollars. Should it be decided in Brooklyn's favor, not only would these large damages be avoided, but a gain in the economics of street pavements of the largest consequences, for the present and the future, would be established for Brooklyn, and by Brooklyn for her sister cities in the several States.

The suit was first brought in January, 1874, and after a long series of meetings and taking of testimony in Brooklyn, Rochester, Buffalo and elsewhere, the case came on for trial before Judge Blatchford, in 1878, and was by him decided in favor of the city, on the ground that Guidet's alleged invention was not a novelty at the time of his issue of letters patent, but was contained in substance and principle in pavements laid down in Rochester and Buffalo thirty or forty years ago.

ARGUMENT FOR APPELLANT.

Mr. Harding, in his argument, took the ground that the patent was not void for want of novelty. He claimed that the pavements which the defendant had shown to have been constructed in Boston and New York were essentially different in character from those covered by the Guidet patent, and that that laid in South street, New York, was suggested by Guidet himself.

In regard to the Buffalo and Rochester pavement, counsel had transported to the Supreme Court a great load of specimens of stones taken up from the streets of those cities, and claimed that these samples demonstrated the difference in character from that covered by Guidet. He compared specifications of the contracts for laying the pavement on Lafayette and Myrtle avenues in Brooklyn, with the letters patent of Guidet to show that those contracts call for the laying of the pavement thus patented, which he insisted differed from the pavement in use prior to the patent in other cities named, and to show the similarity between the pavement laid in Brooklyn and that covered by the patent, he read at length in testimony.

He insisted that the subject-matter of the specifications and claim of the letters patent to Guidet did involve invention. Continuing he said:

A good, firm and durable pavement was greatly desired and needed, and a prime necessity in the great streets of our large cities; and it is a matter of public notoriety and of public scandal, how pavement after pavement had been tried on such streets only to be taken up and replaced by a new venture. Of all the streets in the country, Broadway, in the city of New York, probably stood in greatest need of such a pavement, and here the weakness and faults of one pavement after another were fully demonstrated, until in 1872 Guidet placed upon it his patented pavement, which still remains there, and which was found entirely capable of standing even the tremendous test to which it has there been exposed. Since Guidet's demonstration of the value of the pavement, and how enduring it was even under the travel of Broadway, it has been followed in Brooklyn and by other cities. If Guidet's pavement is no advance upon the Nicolson pavement described in the specification, why does not the city of Brooklyn lay its pavements in that way? On looking back it seems very simple to obtain the open joints of the Nicholson pavement, by roughing the transverse sides, but no one prior to Guidet conceived the idea of making pavements of blocks having the general figure of a parallelopipedon, and having their sides, which were laid transversely to the streets, purposely left or cut rough so as to form such a joint. In all the voluminous proof taken by the respondent, they did not go one step beyond the admissions of the patent as to the prior state of the art.

I submit to your honors that he did a new thing and is entitled to the patent for just what he did do.

ARGUMENT FOR RESPONDENT.

Mr. DeWitt followed in an elaborate and carefully prepared argument, and delivered it with strong effect, considering the importance of the subject and the interest excited by it in Brooklyn. Your correspondent has given considerable space to his remarks, which were substantially as follows, though questions developed many spicy answers as the orator warmed into his subject:

The reissue patent on which this suit is brought is void for want of novelty. The pavement in extensive use in the cities of Rochester and Buffalo long before the time of the alleged invention of Guidet was substantially the same as that attempted to be described in the reissue patent. All that can be covered by this patent, under any construction possible to be put upon it, is that it is for a pavement made of stones of substantially the general form of parallelopipeds, having the end joints relatively close, and the side joints relatively open, for the purposes specified in the patent. Now, all of these conditions were exactly fulfilled by the Rochester and Buffalo pavement. Those pavements had the end joints of the stones relatively as close, and the side joints relatively as open, and for the same purpose as is specified in

the patent, and as much so as any pavement which the proofs show was ever laid down in the city of Brooklyn. It was the practice in Rochester and Buffalo for foremen and superintendents of paving to instruct the pavers to so lay the stones as to form open side joints transversely to the streets, and so as to form close end joints in line with the streets. After such instruction was publicly given and understood to have been acted upon, why was not that alone sufficient to show that what was so directed to be done was a matter of common knowledge? How could it be said that that remained to be discovered which workmen had been repeatedly directed to do with a full understanding of the object and utility of having it done? This piece of testimony alone would be sufficient to invalidate the patent under consideration. The Guidet patent purports to be for a pavement possessing certain properties, and not for the materials composing the pavement. Any peculiarity specified in the material is merely to contribute toward the properties which the pavement is to contain after it is laid in the street. The properties, as far as the patent defines any which characterize the pavement, are:

First—Stones bounded by six faces, each two opposite faces being parallel with each other.

Second—The width of the joints running transversely to the streets are comparatively wide.

Third—The width of the joints running longitudinally to the street are comparatively narrow.

On the part of the appellee twenty-two witnesses testify that the Rochester and Buffalo pavements consisted of stones which were substantially as thick and as long on the bottom as on the top, and substantially as long on one side as on the other, and substantially as wide and as thick on one end as on the other, thus bringing them as nearly to the form of parallelopipeds as the stones in the alleged infringing pavement are proved to be or claimed to be. On the part of the appellee twenty-nine witnesses testify that the joints running longitudinally with the line of the streets are substantially close when compared with the transverse joints. On the part of the appellee, twenty-nine witnesses testify that in the Rochester and Buffalo pavements the joints formed by the sides of the stones and running transversely to the line of the streets are substantially open when compared with the longitudinal joints.

Mr. De Witt criticised at length the plaintiff's testimony and submitted: That in view of the testimony of the Rochester and the Buffalo pavements, the court below was right in holding that the prior use of the pavements laid down in Rochester and Buffalo prior to the date of the alleged invention of the patentee was sufficient to invalidate his patent. He argued that the reissue patent is not for the same invention as was the original, but is for another and different invention, and that fact appears from a comparison of the original and the reissue specifications, and that the claim of the Guidet reissue is not for patentable subject matter. But Mr. De Witt laid the greatest stress upon the point that there was no invention or discovery required in producing the subject matter patented by the reissue patent. The patent for that reason is, therefore, null and void. There is a definable and a defined class of things, which are the products of inventive genius, and a class which are the products of merely mechanical skill, and others which are so obvious as to require neither genius nor skill to produce them. In effecting changes in articles and materials employed in useful arts, two functions of mind are employed. One is the inventive faculty, and the other is mechanical skill. They are the genius of the inventor and the skill of the mechanic. It is often difficult to trace the line between the products of the two, and to determine where the skill of the mechanic leaves off and the genius of the inventor begins. But, notwithstanding that difficulty, the two have a distinct existence, a distinct operation, and produce distinct results, and this has been repeatedly affirmed and acted upon by all courts, both in this and in foreign countries. The following propositions are well settled law, and cannot be denied:

First—That the products of mere mechanical skill are not subjects for patents.

Second—That the products of inventive genius are subjects for patents.

In determining to which class the change belongs reference must be had to the effect as well as the means. No changes or improvements which are obvious can rise higher in dignity than to belong to the products of the mere skill of a person acquainted with the art or manufacture to which the change belongs; and, as already stated, there is a class of changes which are so obvious and so low in the scale as not to require even skill. In considering whether or not the laying of such a pavement as that described in the Guidet patent required anything more than mechanical skill, three things are to be noticed:

1. The functions or properties of the pavement to be produced.

2. The form of the material—that is, the form of the stones to be used.

3. The manner in which the stones are to be laid—that is, their relation to each other.

First—As to the functions or properties of the pavement to be laid.

It must have comparatively tight joints longitudinally, and comparatively open joints transversely. These requirements were for the purpose of preventing ruts being worn by the wheels of vehicles, and to furnish foothold for draught animals. There was no discovery in either of these objects or uses, and none is claimed in behalf of the patentee. Everybody knew that it was useful to prevent horses slipping on the pavement, and useful to prevent ruts being worn into the pavement. There was no invention or discovery in the means proposed to attain these objects. Everybody knew that to prevent wheels wearing ruts between pavement stones tight joints in the direction of the travel of the wheels were the appropriate remedy. This had been familiar knowledge to persons using or observing the use of wheel vehicles as long as such wheels had been used. Everybody knew that open joints crosswise of the streets were the proper means of furnishing foothold for draught animals. This had been familiar knowledge as long as such animals had been used.

Second—As to the form of the material—that is, the form of the stones to be used. There was no novelty in the general form of the stone blocks to be used. If restricted to the form of a parallelopiped, there was no novelty in it, for that was the form of an old well-known mathematical figure, and it was also old in its application to pavement stones, as is proved by the appellee and also admitted by the appellant's patent.

The objects to be attained requiring no discovery, but being matter of common knowledge, and the direction and size of the joints adapted to the attainment of those objects requiring no contrivance or discovery, but being also matter of common knowledge, and the form of stone blocks adopted involving no novelty, it follows that all that remained to be done to produce the pavement patented was to use the appropriate and well-known means of making the longitudinal joints comparatively tight to resist the wearing of ruts, and the transverse joints comparatively open to furnish foothold for draught animals.

Third—As to the manner in which the stones were to be laid—that is, their relation to each other.

Everybody knew that when the surfaces of stones or the surfaces of anything else are to be put in contact, if smooth, they will make a tight joint, and when a tight joint is to be made, everybody knew that smooth surfaces were the proper means of making it. Everybody knew that if an open joint is to be made between the surfaces of stones, or the surfaces of anything else, and that such surfaces are not to be separated by any other material being interposed between them, protuberances on those surfaces are the appropriate means of producing the required joints. The use of such means of producing close and open joints was simply using well-known causes to produce well-known effects, merely doing what was well understood and had been practiced upon for centuries. Again, comparing the patented pavement with the pavement which the patent itself admits was old, shows that there was no patentable invention in the former. What does the patent admit was old? The specifications of the reissue contains the following admission, page ——: "I am aware that pavements have been produced of blocks made in the form of parallelopipeds, but in order to produce open transverse joints, it was found necessary to interpose between the adjoining blocks thin strips of wood or stone." Here, then, is an admission that a pavement was known composed of blocks in the form of parallelopipeds; that it had open transverse joints, and that it was so laid as to intentionally produce open transverse joints. This of course means that the transverse joints were more open than the longitudinal joints. Therefore, the pavement admitted to have been old at the time of Guidet's alleged invention was composed of the same blocks, had the same relative width of joints as the pavement claimed by Guidet. Now, what remained to be done to that old pavement to make it precisely the pavement patented by Guidet?

The only difference between that old pavement and the Guidet pavement is that in the latter the part which separates the sides of the stones to secure an open joint at the top is fast to the side of the stone, while in the old pavement, that part is there, having the same function and doing the same duty, but is not fastened to the side of the stone. It was preposterous to assert that this difference involved the exercise of inventive genius. Mr. DeWitt argued also that no infringement had been proven, and that if there had been the city of Brooklyn is not liable for the infringement of letters patent by its officers, but redress must be had, if at all, against the officers themselves.

Mr. DeWitt in concluding said he rejoiced to be able to close so long a term of service in so good a cause before so grand a tribunal and on the eve of assured success.

Cote.

LITERATURE.

"History of the Water Supply of the World," by Thos. J. Bell, Assistant Superintendent of Cincinnati Water-works.

The above somewhat pretentious title is calculated to raise the expectations of the reader, which the treatment of the subject fails to satisfy.

While there is a large body of information introduced from various sources, it is frequently quite conflicting, and the items introduced with so little connection or relevancy to the matter in hand as to resemble a scrap book of clippings without method or system of arrangement. An index, however, is added which gives a value to the publication as a book of reference.

NOTES.

Cost of Right of Way in England.

Last year a well-known English railway had to buy several pieces of land along its line, and the cost of the transfers furnishes a startling example of the need for reform in conveyancing methods in England. For the land itself a total sum of over $635,000 was paid, for conveyancing charges the company paid an additional $74,500. A piece of land at Bradford cost $16,600; the legal charges on it were $4,960. A piece at Tapton cost $10,000; the charges were $605. Elsewhere some land cost $6,520, and the expenses were $2,840, while there was one case where the charges exceeded the purchase price, being $496 as against $431.

New Building Law.

The new building law now before the New York Legislature is a great improvement upon those now existing. It aims to adapt the regulations of the statute to the most recent improvements in architecture and building, and to remedy the numerous mischiefs recently discovered through falling or condemned buildings or fire and the loopholes in summary procedures. For instance, the new law takes notice (which the existing law did not apparently) that buildings for commercial purposes, and even for some residential purposes, were constructed nine, ten and even eleven stories high, and the new provisions adapt thickness of walls more closely to height. The new statute provides for more securely bracing untopped walls; it forbids mason work in high freezing weather, it provides for lining elevators with iron, and openings at their tops for escape of fire and smoke if these come; for iron or stone steps in high apartment houses or in buildings used for offices; it regulates the safe distances between beams and flues and provides for a heavy lining of flues; it calls for a more perfect testing of iron columns before these are set; it provides for the instantaneous search in ruins for wounded or dying persons, and it takes away much existing looseness of provision as to fire-escapes. The new bill contains exceedingly elaborate enactments as to theatres and places of public resort in building matters. Several sections provide for summoning a jury to try any question as to safety disputed between owners or builders, or either or both, with the building authorities, and in unforeseen cases gives semi-autocratic power to the Inspector and makes the elasticity of the law depend upon the discretion of the head of the building bureau.

Electric Lighting of Railroad Cars.

It is interesting to know that Charles E. Buell, of this city, has recently been awarded letters patent for devices for so controlling electrical storage as to overcome the difficulties encountered by the electrical engineers of Europe, and make the lighting of not only railway trains, but isolated residences and thickly-settled communities by stored electricity not only practicable, but very desirable, his patents obtained, and to be obtained, securing to him every part of an electric lighting system. He thinks a dynamo-electrical machine of two horse-power amply sufficient for lighting the longest railway train by stored energy, and that such machines can be supplied for less than $200 each. He is having an improved form of dynamo machine built at the factory of James Buell & Son, Woburn, Mass., which he thinks will produce a current equal to that produced by 600 cells of the Grove battery, when propelled by a two horse-power motor. His system for railway trains requires no attendance or skill in connecting, in turning on, or off, and requires no replenishing of material consumed. It has been demonstrated that the incandescent lamp will last very much longer at a higher luminosity when used with currents from stored electricity, as compared with currents direct from the dynamo machine. The light emitted from the lamp being due to vibratory motion of the particles of the exceedingly frail filament of carbon and the jerky motion of the propelling engine results sooner or later in rupture of the filament.—*New Haven (Conn.) Palladium, March 28.*